NOAA SCIENTIFIC PUBLICATIONS REPORT
March 27, 2017

HIGHLIGHTED ARTICLES

A framework for ENSO predictability of marine ecosystem drivers along the US West Coast
U.S. CLIVAR Variations (n/a)

Respiratory microbiome of endangered southern resident killer whales and microbiota of surrounding sea surface microlayer in the Eastern North Pacific
Scientific Reports (5.228)

Nowhere to go: Noise impact assessments for marine mammal populations with high site fidelity
Endangered Species Research (1.325)

Overwinter habitat selection by Antarctic krill under varying sea ice conditions: implications for top predators and fishery management
Marine Ecology Progress Series (2.361)

Increase in acidifying water in the western Arctic Ocean
Nature Climate Change (17.184)

CROSS LINE OFFICE ARTICLES

On the skill of seasonal sea surface temperature forecasts in the California Current System and its connection to ENSO variability
Climate Dynamics (4.619)

Nutrient and phytoplankton dynamics on the inner shelf of the eastern Bering Sea
Journal of Geophysical Research Oceans (3.44)

The quantification and correction of wind-induced precipitation measurement errors
Hydrology and Earth System Science (4.40)

ADDITIONAL ARTICLES

NMFS Publications

Integrating lipid storage into general representations of fish energetics
Journal of Animal Ecology (5.196)

Multispecies extensions to a non-equilibrium length-based mortality estimator
Marine and Coastal Fisheries (1.442)

Stream network shape influences the strength of growth and phenological responses to climate change in juvenile salmon
Ecosphere (2.287)

Dynamic population trends observed in the deep-living Pacific flatnose, *Anitmora microlepis*, on the U.S. West Coast
Deep Sea Research Part I: Oceanographic Research (2.684)

International workshop on advancing methods to overcome challenges associated with life history and stock assessments of data-poor deep-water snappers and groupers
Marine Policy (2.610)

Incorporating climate change information into transportation research and design
Journal of Infrastructure Systems (1.26)

Looking into a whale's heart: investigating a genetic basis for cardiomyopathy in a non-model species
Genome (1.424)

Coupled geomorphic and habitat response to a flood pulse revealed by remote sensing
Ecohydrology (2.138)

NOAA SCIENTIFIC PUBLICATIONS REPORT
March 27, 2017

Nocturnal patterns in fish chorusing off the coasts of Georgia and eastern Florida
Bulletin of Marine Science (1.503)

Extremely low allelic diversity of microsatellite markers in the banded guitarfish (*Zapteryx exasperata*)
Conservation Genetic Resources (0.446)

Evidence of natural predation on invasive lionfish, *Pterois* spp. by the spotted moray eel, *Gymnothorax moringa*
Bulletin of Marine Science (1.795)

The potential effects of pre-settlement processes on post-settlement growth and survival of juvenile northern rock sole (*Lepidopsetta polyxystra*) Gulf of Alaska nursery habitats
Estuarine, Coastal, and Shelf Science (2.762)

Experimental assessment of circle versus J hook performance and selectivity in the northern Gulf of Mexico recreational reef fish fishery
ICES Journal of Marine Science (2.626)

Bayesian stock assessment of Pacific herring in Prince William Sound, Alaska
PLOS ONE (3.234)

Evolutionary restoration potential evaluated through the use of a trait-linked genetic marker
Evolutionary Applications (4.572)

Facilitation in Caribbean coral reefs: high densities of staghorn coral foster greater coral condition and reef fish composition
Oecologia (2.902)

Growth and maturation of the red lip parrotfish *Scarus rubroviolaceus*
Journal of Fish Biology (1.658)

Assessing the diet of North American Atlantic salmon (*Salmo salar* L.) off the West Greenland coast using gut content and stable isotope analyses

Fisheries Oceanography (2.73)

OAR Publications

Exploring the ocean for hydrothermal venting: New techniques, new discoveries, new insights

Ore Geology Reviews (3.72)

Focusing of internal tides by near-inertial waves

Geophysical Research Letters (4.212)

Calculating surface ocean pCO2 from biogeochemical ARGO floats equipped with pH - an uncertainty analysis

Global Biogeochemical Cycles (4.495)

A practical set of miniaturized instruments for vertical profiling of aerosol physical properties

Aerosol Science and Technology (1.953)

Assessment of the underestimation of snowfall accumulation by tipping bucket gauges used operationally by the Spanish national weather service

Atmospheric Measurement Techniques (2.989)

On the role of sea-state in bubble-mediated air-sea gas flux during a winter storm

Journal of Geophysical Research Oceans (3.44)

NESDIS Publications

Circulation analysis in the northwest Indian Ocean using ARGO floats and surface drifter observations, and SODA reanalysis output

Dynamics of Atmospheres and Oceans (1.439)

HIGHLIGHTED ARTICLES

A framework for ENSO predictability of marine ecosystem drivers along the US West Coast
U.S. CLIVAR Variations (n/a)
Editors: E. Di Lorenzo, A. J. Miller
Section authors: M. D. Ohman, **N. Mantua (NMFS/SWFSC)**, J. Keister, M. Garcia-Reyes, **S. McClatchie (NMFS/SWFSC), A. Capotondi (OAR/ESRL),** K. Karnauskas, A. Miller, and A. Subramanian, **M. G. Jacox (NMFS/SWFSC)**, D. L. Rudnick, C. A. Edwards, C. Anderson, S. Siedlecki, C. Rousseaux, B. Powell, **B. Peterson (NMFS/NWFSC)**, C. Edwards, **E. Hazen (NMFS/SWFSC)**, **M. Alexander (OAR/ESRL), S. Bograd (NMFS/SWFSC)**, A. J. Hobday, R. Rykaczewski, **K. L. Scales (NMFS/SWFSC)**, D. Tommasi, **F. E. Werner (NMFS/SWFSC)**, **C. A. Stock (OAR/GFDL**), and N. A. Bond

- Over the last 60 years a wide range of observations in the California Current System have been recorded along the US west coast, yet no systematic attempt exists to forecast local marine ecosystem responses to individual ENSO events.
- The authors provide a framework from physics to top predators for understanding and predicting ENSO effects on the California Current.

The US West Coast eastern boundary upwelling system supports one of the most productive marine ecosystems in the world and is a primary source of ecosystem services for the US (e.g., fishing, shipping, and recreation). Long-term historical observations of physical and biological variables in this region have been collected since the 1950s (e.g., the CalCOFI program and now including the coastal ocean observing systems), leading to an excellent foundation for understanding the ecosystem impacts of dominant climate fluctuations such as the El Niño-Southern Oscillation (ENSO). In the northeast Pacific, ENSO impacts a wide range of physical and biotic processes, including temperature, strati cation, winds, upwelling, and primary and secondary production. The El Niño phase of ENSO, in particular, can result in extensive geographic habitat range displacements and altered catches of fishes and invertebrates, and impact vertical and lateral export fluxes of carbon and other elements (Jacox et al., this issue; Anderson et al., this issue; Ohman et al., this issue). However, despite empirical observations and increased understanding of the coupling between climate and marine ecosystems along the US West Coast, there has been no systematic attempt to use this knowledge to forecast marine ecosystem responses to individual ENSO events.

ENSO forecasting has become routine in the climate community. However, little has been done to forecast the impacts of ENSO on ecosystems and their services. This becomes especially important considering the occurrence of recent strong El Niño events (such as 2015-16) and climate model projections that suggest that ENSO extremes may become more frequent (Cai et al. 2015).
Publication date: February 13, 21017
Available online: https://indd.adobe.com/view/1f2e94f8-2c3b-4371-bd88-12fec4d1ba6b

Respiratory microbiome of endangered southern resident killer whales and microbiota of surrounding sea surface microlayer in the Eastern North Pacific
Scientific Reports (5.228)
S. A. Raverty, **L. D. Rhodes**, E. Zabek, A. Eshghi, C. E. Cameron, **M. B. Hanson (NMFS/NWFSC)**, and J. P. Schroeder

- The respiratory microbiome of ESA-listed southern resident killer whales has potential as a non-invasive health assessment method.
- This study demonstrates that exhaled breath samples can be analyzed for both commensal and pathogenic bacteria and fungi.
- The results encourage further use of exhaled breath for individual animal evaluations.

In the Salish Sea, the endangered Southern Resident Killer Whale (SRKW) is a high trophic indicator of ecosystem health. Three major threats have been identified for this population: reduced prey availability, anthropogenic contaminants, and marine vessel disturbances. These perturbations can culminate in significant morbidity and mortality, usually associated with secondary infections that have a predilection to the respiratory system. To characterize the composition of the respiratory microbiota and identify recognized pathogens of SRKW, exhaled breath samples were collected between 2006-2009 and analyzed for bacteria, fungi and viruses using (1) culture-dependent, targeted PCR-based methodologies and (2) taxonomically broad, non-culture dependent PCR-based methodologies. Results were compared with sea surface microlayer (SML) samples to characterize the respective microbial constituents. An array of bacteria and fungi in breath and SML samples were identified, as well as microorganisms that exhibited resistance to multiple antimicrobial agents. The SML microbes and respiratory microbiota carry a pathogenic risk which we propose as an additional, fourth putative stressor (pathogens), which may adversely impact the endangered

SRKW population.
Publication date: March 24, 2017
Available online: https://doi:10.1038/s41598-017-00457-5

Nowhere to go: Noise impact assessments for marine mammal populations with high site fidelity
Endangered Species Research (1.325)
K. A. Forney, B. L. Southall, E. Slooten, S. Dawson, A. J. Read, R. W. Baird, and **R. L. Brownell Jr. (NMFS/SWFSC)**

- This paper presents several case studies of small, localized cetacean populations to illustrate the need for considering additional mechanisms of adverse biological impacts of anthropogenic noise, particularly the effects of displacement.
- A new framework for considering potential harmful impacts on such populations is proposed and demonstrated for the case studies.
- Effective and responsible mitigation of disturbance for such populations requires substantial advance planning, multi-year baseline studies, and well-designed monitoring and mitigation, as well as a new way of thinking about how effects may manifest themselves in animals that either choose to tolerate or avoid disturbance.

As awareness of the effects of anthropogenic noise on marine mammals has grown, research has broadened from evaluating physiological responses including injury and mortality to considering effects on behavior and acoustic communication. Most mitigation efforts attempt to minimize injury by enabling animals to move away as noise levels are increased gradually. Recent experiences demonstrate that this approach is inadequate or even counterproductive for small, localized marine mammal populations, for which displacement of animals may itself cause harm. Seismic surveys within the ranges of harbor porpoise (*Phocoena phocoena*) in California and Māui dolphin (*Cephalorhynchus hectori maui*) in New Zealand highlight the need to explicitly consider biological risks posed by displacement during survey planning, monitoring, and mitigation. Consequences of displacement are poorly understood, but likely include increased stress and reduced foraging success, with associated effects on survival and reproduction. In some cases, such as with the Critically Endangered Māui dolphin, displacement by seismic activities risks exposing the remaining 55 dolphins to bycatch in nearby fisheries. Similar concerns about military and industrial activities exist for island-associated species such as melon-headed whales (*Peponocephala electra*) in Hawai'i; shelf-break

associated species such as Cuvier's beaked whales (*Ziphius cavirostris*) off U.S. Atlantic coast, and whales foraging in coastal habitats, such as the endangered Western gray whale (*Eschrichtius robustus)*. We present an expanded framework for considering disturbance effects that acknowledges scientific uncertainty, providing managers and operators a more robust means of assessing and avoiding potential harm associated with both displacement and direct effects of intense anthropogenic noise exposure.
Acceptance date: February 20, 2017
Available online: https://doi.org/10.3354/esr00820

Overwinter habitat selection by Antarctic krill under varying sea ice conditions: implications for top predators and fishery management
Marine Ecology Progress Series (2.361)
C. S. Reiss, A. Cossio, J. A. Santora, K. S. Dietrich, A. Murray, B. G. Mitchell, **J. Walsh,** E. L. Weiss, C. Gimpel, **C. D. Jones,** and **G. M. Watters (NMFS/SWFSC)**

- This study provides the first estimate of krill biomass in winter on the Antarctic Peninsula.
- The study documented overwinter habitat or krill and krill-dependent predators in this region.
- Presence of ice-dependent winter krill and trends in decreases in sea ice in this region has the potential to increase fishery-predator-prey interactions as seasonal ice declines.

Climate change will affect Antarctic krill (*Euphausia superba*), krill-dependent predators, and fisheries in the Southern Ocean as areas typically covered by sea ice become ice-free in some winters. Research cruises conducted around the South Shetland Islands of the Antarctic Peninsula during winters with contrasting ice conditions provide the first acoustic estimates of krill biomass, habitat use, and association with top predators to examine potential interactions with the krill fishery. Krill abundance was very low in offshore waters during all winters. In Bransfield Strait, median krill abundance was an order of magnitude higher (8 krill m^{-2}) compared to summer (0.25 krill m^{-2}), and this pattern was observed in all winters regardless of ice cover. Acoustic estimates of krill biomass were also an order of magnitude higher (~5 500 000 tons in 2014) than a 15-year summer average (520 000 tons). During winter, crabeater seals (*Labodon carcinophagus*) were concentrated in Bransfield Strait where ice provided habitat, while Antarctic fur seals (*Arctocephalus gazella*) were more broadly distributed. Krill overwinter

in coastal basin environments independent of ice and primary production and in an area that is becoming more frequently ice-free. While long-term projections of climate change have focused on changing krill habitat and productivity declines, more immediate impacts of ongoing climate change include increased risks of negative fishery-krill-predator interactions, alteration of upper trophic level community structure, and changes in the pelagic ecology of this system. Development of management strategies to mitigate the increased risk to krill populations and their dependent predators over management timescales will be necessary to minimize the impacts of long term climate change.
Publication date: March 24, 2017
Available online: http://www.int-res.com/articles/feature/m568p001.pdf

Increase in acidifying water in the western Arctic Ocean
Nature Climate Change (17.184)
D. Qi, L. Chen, B. Chen, Z. Gao, W. Zhong, **R. A. Feely (OAR/PMEL),** L. G. Anderson, H. Sun, J. Chen, M. Chen, L. Zhan, Y. Zhang, and W.-J. Cai

- Decreases in pH and carbonate mineral aragonite saturation state (which is indicative of ocean acidification) within the Arctic Ocean waters have expanded northwards at least 5°, to 85° N, and deepened 100 m, to 250 m depth between the 1990s and 2010.
- Results from tracer data and model simulations indicate that more rapid acidification is occurring in the Arctic Ocean than in Pacific or Atlantic oceans and increased Pacific Winter Water transport (due to an anomalous circulation pattern and sea-ice retreat) is primarily responsible.
- Could have a negative impact on marine ecosystems and organisms.

The uptake of anthropogenic CO2 by the ocean decreases seawater pH and carbonate mineral aragonite saturation state (Ωarag), a process known as Ocean Acidification (OA). This can be detrimental to marine organisms and ecosystems. The Arctic Ocean is particularly sensitive to climate change and aragonite is expected to become undersaturated (Ωarag < 1) there sooner than in other oceans. However, the extent and expansion rate of OA in this region are still unknown. Here we show that, between the 1990s and 2010, low Ωarag waters have expanded northwards at least 5°, to 85° N, and deepened 100 m, to 250 m depth. Data from trans-western Arctic Ocean cruises show that Ωarag < 1 water has increased in the upper 250 m from 5% to 31% of the total area north of 70° N. Tracer data and model simulations suggest that increased Pacific Winter Water transport, driven by an anomalous circulation pattern and sea-ice retreat, is primarily responsible for

the expansion, although local carbon recycling and anthropogenic CO2 uptake have also contributed. These results indicate more rapid acidification is occurring in the Arctic Ocean than the Pacific and Atlantic oceans, with the western Arctic Ocean the first open-ocean region with large-scale expansion of 'acidified' water directly observed in the upper water column.
Publication date: February 27, 2017
Available online:
http://www.nature.com/nclimate/journal/v7/n3/full/nclimate3228.html

CROSS LINE OFFICE ARTICLES

On the skill of seasonal sea surface temperature forecasts in the California Current System and its connection to ENSO variability
Climate Dynamics (4.619)
M. Jacox (NMFS/SWFSC), M. Alexander (OAR/ESRL), C. Stock (OAR/GFDL), and G. Hervieux (OAR/ESRL)

- Considerable seasonal forecast skill (1-12 month forecasts) is found for sea surface temperature (SST) in the California Current System through this study.
- SST forecast skill comes mainly from persistence and ENSO variability.
- Skillful SST forecasts can be combined with habitat models for use in dynamic fisheries management.

The California Current System (CCS) is a biologically productive Eastern Boundary Upwelling System that experiences considerable environmental variability on seasonal and interannual timescales. Given that this variability drives changes in ecologically and economically important living marine resources, predictive skill for regional oceanographic conditions is highly desirable. Here, we assess the skill of seasonal sea surface temperature (SST) forecasts in the CCS using output from Global Climate Forecast Systems in the North American Multi-Model Ensemble (NMME), and describe mechanisms that underlie SST predictability. A simple persistence forecast provides considerable skill for lead times up to ~4 months, while skill above persistence is mostly confined to forecasts of late winter/spring and derives primarily from predictable evolution of ENSO-related variability. Specifically, anomalously weak (strong) equatorward winds are skillfully forecast during El Niño (La Niña) events, and drive negative (positive) upwelling anomalies and consequently warm (cold) temperature anomalies. This mechanism prevails during moderate to strong ENSO events, while years of

ENSO-neutral conditions are not associated with significant forecast skill in the wind or significant skill above persistence in SST. We find also a strong latitudinal gradient in predictability within the CCS; SST forecast skill is highest off the Washington/Oregon coast and lowest off southern California, consistent with variable wind forcing being the dominant driver of SST predictability. These findings have direct implications for regional downscaling of seasonal forecasts and for short-term management of living marine resources.
Acceptance date: February 23, 2017

Nutrient and phytoplankton dynamics on the inner shelf of the eastern Bering Sea
Journal of Geophysical Research Oceans (3.44)
C. W. Mordy, A. Devol, **L. B. Eisner (NMFS/AKFSC)**, N. Kachel, **C. Ladd (OAR/PMEL),** M. W. Lomas, P. Proctor, R. N. Sambrotto, D. H. Shull, **P. J. Stabeno (OAR/PMEL),** and E. Wisegarver

- The inner shelf is primarily a regenerative system even in spring, although new production can occur at the inner front (dependent on stratification, wind mixing and winter replenishment).
- Correlations between winter replenishment and summertime concentrations of phytoplankton biomass (i.e., chlorophyll-a) over portions of the inner shelf indicate that the influence of winter replenishment on the ecosystem is prolonged, and partly governs energy flow through the ecosystem.

The nitrogen cycle on the inner shelf of the southeastern Bering Sea is complicated due to limited nutrient replenishment across this broad shelf, and substantial nitrogen loss through sedimentary processes. While diffusion at the inner front may periodically support new production, the shelf is generally hypothesized to be a regenerative system. This study uses a combination of hydrographic surveys, and measurements of nitrogen assimilation and benthic fluxes to examine nitrogen cycling on the inner shelf, and connectivity between the middle and 38 inner shelves of the southern and central Bering Sea. Results establish the inner shelf as primarily a regenerative system even in spring, although new production can occur at the inner front. Results also identify key processes that influence nutrient supply to the inner shelf, and reveal coupling between the middle shelf nutrient pool and production on the inner shelf.
Publication date: March 24, 2017
Available online: http://onlinelibrary.wiley.com/doi/10.1002/2016JC012071/full

The quantification and correction of wind-induced precipitation measurement errors

Hydrology and Earth System Sciences (4.40)

J. Kochendorfer (OAR/ARL), R. Rasmussen, M. Wolff, **B. Baker (OAR/ARL), M. E. Hall (OAR/ARL), T. Meyers (OAR/ARL),** S. Landolt, A. Jachcik, K. Isaksen, R. Brækkan, and **R. Leeper (NESDIS/NCEI)**

- Snowfall measurements recorded using precipitation gauges are subject to significant underestimation due to the effects of wind. This underestimation introduces significant errors in the measured amount of precipitation, and hampers our ability to predict flooding, assess water availability, monitor climate and weather, and validate meteorological and climate models.

Hydrologic measurements are becoming increasingly important for both the short and long term management of water resources. Of all the terms in the hydrologic budget, precipitation is the typically most important input. However, measurements of precipitation are still subject to large errors and biases. For example, a high-quality but unshielded weighing precipitation gauge can collect less than 50% of the actual amount of solid precipitation when wind speeds exceed 5 m s−1. Using results from two different precipitation testbeds, such errors have been assessed for unshielded weighing gauges and for four of the most common windshields currently in use. Functions used to correct wind-induced undercatch were developed and tested. In addition, corrections for the single Altar weighing gauge were developed using the combined results of two separate sites, one of which was in Norway and other in the US. In general the results indicate that corrections described as a function of air temperature and wind speed effectively remove the undercatch bias that affects such precipitation measurements. In addition, a single 'universal' function developed for the single Altar gauges effectively removed the bias at both sites, with the bias at the US site improved from −12% to 0%, and the bias at the Norwegian site improved from −27% to −3%. These correction functions require only wind speed and air temperature, and were developed for use in national and local precipitation networks, hydrological monitoring, roadway and airport safety work, and climate change research. The techniques used to develop and test these transfer functions at more than one site can also be used for other more comprehensive studies, such as the WMO Solid Precipitation Intercomparison Experiment.

Publication date: September 9, 2016

Available online: http://www.hydrol-earth-syst-sci-discuss.net/hess-2016-415/hess-2016-415.pdf

ADDITIONAL ARTICLES

NMFS Publications

Integrating lipid storage into general representations of fish energetics
Journal of Animal Ecology (5.196)
B. Martin, R. Heintz, **E. Danner (NMFS/SWFSC)**, and R. Nisbet

- The authors synthesize data from a wide range of fish species to identify patterns of energy storage.
- The authors generated a general model of energy allocation between growth, lipid storage, and reproduction in fishes.
- The study found that many seemingly complex, adaptive energy allocation strategies in response to ontogeny, seasonality, and habitat quality can emerge from a simple model based on physiology.

Fish, even of the same species, can exhibit substantial variation in energy density (energy per unit wet weight). Most of this variation is due to differences in the amount of storage lipids. In addition to their importance as energy reserves for reproduction and for survival during unfavorable conditions, the accumulation of lipids represents a large energetic flux for many species, so figuring out how this energy flux is integrated with other major energy fluxes (growth, reproduction) is critical for any general theory of organismal energetics.
Here we synthesize data from a wide range of fish species and identify patterns of intraspecific variation in energy storage, and use these patterns to formulate a general model of energy allocation between growth, lipid storage, and reproduction in fishes.
From the compiled data we identified two patterns: (1) energy density increases with body size during the juvenile period, but is invariant with body size within the adult size range for most species, and (2) energy density changes across seasons, with depletion over winter, but increases fastest in periods of transition between favorable and unfavorable conditions for growth (i.e. fall).
Based on these patterns we propose DEBlipid, a simple, general model of energy allocation that is closely related to a simplified version of Dynamic Energy Budget theory, DEBkiss. The crux of the model is that assimilated energy is partitioned, with κ fraction of energy allocated to pay maintenance costs first, and the surplus allocated to growth, and 1- κ fraction of assimilated energy is allocated to accumulating storage lipids during the juvenile phase, and later to reproduction as adults. This mechanism, in addition to capturing the two patterns that motivated

the model, was able to predict lipid dynamics in a novel context, the migration of anadromous fish from low food freshwater to high food marine environments. Furthermore, the model was used to explain intra and interspecific variation in reproductive output based on patterns of lipid accumulation as juveniles. Our results suggest that many seemingly complex, adaptive energy allocation strategies in response to ontogeny, seasonality, and habitat quality can emerge from a simple physiological heuristic.
Acceptance date: March 13, 2017

Multispecies extensions to a non-equilibrium length-based mortality estimator
Marine and Coastal Fisheries (1.442)
Q. C. Huynh, T. Gedamke, J. M. Hoenig, and **C. Porch (NMFS/SEFSC)**

- The mean length mortality estimator on multispecies approach was used to identify concomitant trends in mortality for three Puerto Rican handline fishery snapper species: Silk, Blackfin, and Vermilion.

Recent advances in methodology allow the history of the total mortality rate experienced by a population to be estimated from periodic (e.g., annual) observations on the mean length of the population. This approach is generalized to allow data on several species that are caught together to be analyzed simultaneously based on the theory that changes in fishing effort are likely to affect several species; thus, the estimation of times when the mortality rate changes for one species borrows strength from data on other, concurrently caught species. Information theory can be used to select among models describing the degree of synchrony (if any) in mortality changes for a suite of species. This approach is illustrated using data on Puerto Rican handline fishery catches of three snapper species: Silk Snapper Lutjanus vivanus, Blackfin Snapper L. buccanella, and Vermilion Snapper Rhomboplites aurorubens. We identified the best model as one that provided for simultaneous decreases in mortality rate around the year 1997 and for separate, species-specific magnitudes of change in total mortality. The simultaneous estimation of parameters for multiple species can provide for more credibility in the inferred mortality trends than is possible with independent estimation for each species.
Publication date: March 1, 2017
Available online:
http://www.tandfonline.com/doi/full/10.1080/19425120.2016.1259696

Stream network shape influences the strength of growth and phenological responses to climate change in juvenile salmon

Ecosphere (2.287)

A. H. Fullerton, **B. J. Burke (NMFS/NWFSC),** J. J. Lawler, C. E. Torgersen, J. L. Ebersole, and S. G. Leibowitz

- A spatially-structured, individual-based model was used for Chinook salmon to evaluate growth and phenology under six temperature and three spatial complexity scenarios.
- Model results determined growth was positive and large with warm summer maximum temperature, positive and slow with earlier spring warming, and negative and slow in variable thermal regimes.

Thermally diverse freshwater habitats may afford fish protection from climate change by providing opportunities to behaviorally optimize growing conditions. However, it is unclear what role the spatial properties of river networks will play in determining risk. We hypothesized that climate change will alter growth and timing of life history events such as hatching or migration timing; but that changes will be moderated in spatially complex stream networks where opportunities to thermoregulate are high. We developed a spatially-structured, individual-based model for Chinook salmon (*Oncorhynchus tshawytscha*) in which movement decisions and growth were governed by water temperature and conspecific density. We evaluated growth and phenology under six thermal regime scenarios (each having different maxima, rates of warming, and variability) in each of three network shapes of increasing spatial complexity. In a cool thermal scenario, salmon grew best and were ready to smolt earliest in the network having the lowest spatial complexity. In warmer scenarios, fish grew best and were capable of smolting earliest in the most spatially complex network where water temperatures experienced by fish were ~2°C closer to optimal temperatures for growing. Growth was positive and large given warmer summer maxima, positive and small given earlier spring warming, and negative and small given variable thermal regimes. Conclusions. Our results demonstrate that network topology may influence how fish respond to future thermal landscapes, and should help conservation planners incorporate a spatiotemporal context into decisions that will best promote long-term viability of salmon under climate change.

Acceptance Date: January 17, 2017

Dynamic population trends observed in the deep-living Pacific flatnose, Anitmora microlepis, *on the U.S. West Coast*

Deep Sea Research Part I: Oceanographic Research (2.684)

P. H. Frey, A. A. Keller, and V. Simon (NMFS/NWFSC)

- This study presents findings on the spatial distribution, population structure, and relative abundance of the Pacific flatnose, *Antimora microlepis*, by using data from the Northwest Fisheries Science Center's West Coast Groundfish Bottom Trawl Survey from 2003-2015.
- Results showed evidence of highly episodic recruitment which may affect the resilience of this stock to fishing mortality over time.

As fisheries managers attempt to incorporate ecosystem-based considerations into decision making, it is important to understand the role that non-target species play in the ecosystems that support commercial fisheries. For some deep-water groundfishes, basic information on biology and population dynamics is extremely limited. This study presents findings on the spatial distribution, population structure, and relative abundance of the Pacific flatnose, *Antimora microlepis*, using data collected from 2003 to 2015 by the Northwest Fisheries Science Center's West Coast Groundfish Bottom Trawl Survey (WCGBTS). We observed a 67% increase in mean fork-length over the study period reflecting the advancement of strong year-classes from the early 2000s that currently dominate the population as a whole. Catch-weighted depth increased significantly as these cohorts migrated to deeper waters of the continental slope. Although catch per unit effort remained relatively constant, this demographic shift suggests that episodic recruitment may affect the resilience of this stock to fishing mortality over time. A notable decrease in the percentage of females observed after 2012 seemed to indicate the movement of large, older females to depths beyond the 1280 m limit of the survey. Otolith weight provided a useful proxy for age in growth models for this species.

Publication date: March 16, 2017
Available online:
http://www.sciencedirect.com/science/article/pii/S0967063716303843

International workshop on advancing methods to overcome challenges associated with life history and stock assessments of data-poor deep-water snappers and groupers

Marine Policy (2.610)

S. J. Newman , C. B. Wakefield, A. J. Williams, **J. M. O'Malley**, **B. M. Taylor**, S. J. Nicol, **R. S. Nichols**, A. Hesp, N. G. Hall, N. Hill, J. L. L. Ong, **A. H. Andrews (NMFS/PIFSC)**, C. M. Wellington, E. S. Harvey, P. Mous, Z. S. Oyafuso, C. Pardee, M. Bunce, J. D. DiBattista, and B. R. Moore

- This paper summarizes the discussions on current and emerging methods for obtaining life history information, ecological assessments, and stock assessments for deep-water demersal fish that took place at a workshop.
- Many new and refined strategic directions for future studies were identified to resolve uncertainty in monitoring and assessment approaches to contribute toward more rigorous fisheries management.

Most fisheries for deep-water snappers, groupers and other demersal fishes in many countries and territories throughout the Indo-Pacific are data-poor and/or resource-poor. Current and emerging methods for obtaining important information on life history, ecological assessments, and stock assessments for these deep-water species were discussed at an international workshop in Perth, Western Australia in July 2016. The key issues raised included: (i) the ongoing need to adopt nascent methods for otolith sectioning and interpretation; (ii) the need for standardised international ageing protocols to be documented; (iii) the benefits of investigating otolith chronologies both for age validation and the influence of climate variability on fish populations; (iv) a need to investigate the ecological niches and requirements for deep-water fishes; (v) improved understanding of genetic stock structure/connectivity, diet and gene flow across a range of spatial scales; (vi) the need for an improved understanding of the performance and uncertainty associated with length- and age-based catch curves and spawning potential ratio stock assessments; and (vii) the issues and challenges in developing harvest strategies for deep-water, data and/or resource poor resources. Many new or refined strategic directions for further investigation were identified to resolve uncertainty in monitoring and assessment approaches to contribute toward more rigorous fisheries management arrangements.

Publication date: March 19, 2017
Available online: http://dx.doi.org/10.1016/j.marpol.2017.02.009

Incorporating climate change information into transportation research and design
Journal of Infrastructure Systems (1.26)
E. Douglas, J. Jacobs, K. Hayhoe, L. Silka, J. Daniel, **M. Collins (NMFS/OHC)**, A. Alipour, B. Anderson, C. Hebson, E. Mecray, R. Mallick Q. Zou, P. Kirshen, H. Miller, J. Kartez, L. Friess, A. Stoner, E. Bell, C. Schwartz, N. Thomas, S. Miller, B. Audet, and C. Wake

- Climate change presents challenges to the infrastructure sector that require close collaboration between climate scientists and engineers, disciplines with little history of doing so.
- We present specific guidance for partnerships and methods to effectively address the complex questions involved and the co-generation of knowledge that is required.

The vulnerability of our nation's transportation infrastructure to climate change and extreme weather is now well documented and the transportation community has identified numerous strategies to potentially mitigate these vulnerabilities. The challenges to the infrastructure sector presented by climate change can only be met through collaboration between the climate science community, who evaluate what the future will likely look like, and the engineering community, who implement our societal response. To facilitate this process, we ask: what progress have we made and what do we need to do now in order to allow for the graceful convergence of these two disciplines? In late 2012, The Infrastructure and Climate Network (ICNet; www.theicnet.org), a National Science Foundation supported Research Collaboration Network, was established to answer that question. This article presents examples of how the ICNet experience has shown the way towards a new generation of innovation and cross-disciplinary research, challenges that can be addressed by such collaboration and specific guidance for partnerships and methods to effectively addressing complex questions requiring co-generation of knowledge.

Looking into a whale's heart: Investigating a genetic basis for cardiomyopathy in a non-model species
Genome (1.424)
A. Viricel* and **P. E. Rosel (NMFS/SEFSC)**
**A. Viricel was a graduate student at University of Louisiana, working at SEFSC-Lafayette with Dr. Rosel when this work was completed.*

- The study may have identified some genetic loci that show correlation with cardiomyopathy disease.

- The findings suggest that some of the identified mutations may contribute to the development of cardiomyopathy (CM) in the pygmy sperm whale (*Kogia breviceps*), and that environmental factors may modulate their effect.
- The study illustrates the value of studying non-model organisms and of the comparative method for increasing our knowledge of diseases in wild populations.

Understanding the pathogenesis of complex diseases can benefit from multi-species comparative studies. Yet, these studies rarely include natural populations of non-model species. Here, we focused on the cause of a heart muscle disease, cardiomyopathy (CM), affecting multiple mammalian species including humans, cats, dogs, and certain species of whales. Mutations in genes coding for sarcomeric proteins have been identified as a leading cause for CM in humans, and some were also revealed to be responsible for CM in cats. We investigated whether similar mutations could be detected in the deep-diving pygmy sperm whale (*Kogia breviceps*), which is one of two cetacean species that can display CM. We sequenced portions of two candidate genes (MYH7: 3153 bp and MYBPC3: 3019 bp) in 55 whales including affected and unaffected individuals. Mutation screening revealed six nonsynonymous substitutions that were predicted to have an effect on protein function. However, the etiology of CM is likely complex and probably multi-factorial as three of these mutations were also observed in unaffected individuals. This incomplete penetrance could be partly age-related and could also be due to the influence of environmental factors on the development of CM, as seen in humans.
Acceptance date: February 24, 2017

Coupled geomorphic and habitat response to a flood pulse revealed by remote sensing
Ecohydrology (2.138)
L. Harrison, A. Pike, and **D. Boughton (NMFS/SWFSC)**

- Our manuscript quantified the geomorphic and habitat response to a large flood pulse in high-resolution at the riverscape scale.
- We found that the flood doubled the number of pools, improved overall habitat connectivity, and increased the capacity of the river to support juvenile steelhead.
- The integrated field, remote sensing, and modeling approach could be used in large-scale flow experiments and river restoration projects aimed at enhancing habitat diversity.

Despite a growing consensus on the importance of floods in structuring river ecosystems, predicting the geomorphic and habitat response to specific flood pulses across a range of scales remains challenging. We used a large reservoir release in a semi-arid river to characterize geomorphic and habitat responses to a flood pulse, using an integrated field, remote sensing, and modeling approach. Large-scale geomorphic changes were observed as a result of the flood, including lateral migration of the river channel, gravel bar formation and development of off-channel chutes. Spatial patterns of gravel storage varied with downstream distance from a large dam, with the upper 20 km experiencing a net sediment deficit and the lower 60 km undergoing net deposition. The longitudinal trends in gravel transport and storage reflected differences in channel gradient and predicted values of sediment mobility. The flood lowered the channel by an average of -0.5 m and roughly doubled the areal extent of pools, by incising new pools in curved reaches and in areas where the river abutted valley walls and terraces. The increased pool abundance provided greater habitat connectivity and was predicted to have positive impacts on anadromous steelhead, providing up to a 3-fold increase in the number of juvenile fish the river could support. Results from this study highlight the value of using flood pulses as opportunities to learn about river behavior, and for testing the degree to which physical processes can help restore the form and function of river ecosystems.
Publication date: February 9, 2017
Available online: http://onlinelibrary.wiley.com/doi/10.1002/eco.1845/full

Nocturnal patterns in fish chorusing off the coasts of Georgia and eastern Florida
Bulletin of Marine Science (1.503)
A. Rice, **M. Soldevilla**, and **J. Quinlan (NMFS/SEFSC)**

- The ocean soundscape was monitored at five sites off the coasts of Georgia and Florida between November 2012 and April 2013 using an array of passive Marine Autonomous Recording Units (MARUs). Acoustic data from the MARUs were analyzed using novel Acoustic Indices and Long-Term Spectrographic Analysis (LTSA).
- The analyses revealed a variety of sounds produced by soniferous fishes (e.g., black drum, red drum, oyster toadfishes, and several others) that displayed striking diversity in chorusing over the course of a single day (diel variability), and spatially over the course of several months.
- The project indicates that long-term passive acoustic monitoring (PAM) can yield important insights into spatial and temporal patterns of reproduction in

soniferous fishes. To the best of our knowledge, PAM represents the only method to collect such highly resolved data with respect to time (continuously across several months) and space (multiple sites can cover 100s of km). If further developed, this capability has important implications for fisheries science and assessments.

Fish chorusing is a major component of the marine acoustic environment, and much of this chorusing activity happens at night. These nocturnal sounds are commonly associated with reproductive behavior. For many co-occurring taxa, increases in vocal activity may intensify acoustic competition within a constrained signaling environment; for nocturnal species, there is a limited time window for these critical behaviors, and competition to be heard by conspecifics likely increases. Using passive acoustic recording units deployed in the nearshore waters off Georgia and Eastern Florida, we evaluated the nocturnal acoustic habits of fishes and examined how the sounds from nocturnal fish chorusing contribute to the overall soundscape. We examined long-term spectrograms for spatial and temporal patterns of fish calling. Black drum and toadfish dominated the nocturnal acoustic scene, but calls of other identified (e.g., red drum, silver perch) and unidentified calling species also occur. We examined the acoustic indices of entropy, acoustic diversity, and acoustic complexity to compare nocturnal and diurnal fish calling activity across the region. When sustained fish chorusing activity increases, entropy and acoustic diversity decrease, but acoustic complexity increases. With the acoustic differences in composition of nocturnally- and diurnally-active species groups, there is a different nocturnal soundscape than during the day. Passive acoustic surveys represent an exciting approach to understand the nocturnal reproductive activity of coastal fishes.
Publication date: March 22, 2017
Available online: https://doi.org/10.5343/bms.2016.1043

*Extremely low allelic diversity of microsatellite markers in the banded guitarfish (*Zapteryx exasperata*)*
Conservation Genetic Resources (0.446)
A. Castillo-Páez, **J. C. Garza (NMFS/SWFSC)**, M. Á. del Río-Portilla, C. I. Bisbal-Pardo and A. Rocha-Olivares

- This note describes novel genetic markers for a species of fishery importance in Mexico and documents low genetic diversity relative to our related ray and skate species.

Acceptance date: February 12, 2017

Evidence of natural predation on invasive lionfish, Pterois *spp. by the spotted moray eel*, Gymnothorax moringa
Bulletin of Marine Science (1.795)
R. C. Muñoz (NMFS/SEFSC)

- Previously recorded predation on invasive lionfish was "unnatural" predation on an earlier speared and injured lionfish.
- This reports the regurgitation of a lionfish by a spotted moray eel that was recovered in a chevron trap deployed in a remote location off Florida, USA. The author argues that the probability of any event other than natural predation outside the trap seems highly unlikely.
- Therefore, this may be the first recorded natural predation event of lionfish. Predation of lionfish by moray eels may warrant further study given their specialized feeding mechanisms and ability to attain large size and high density in certain locations in the Caribbean Sea and western Atlantic Ocean, potentially a mortality source for these invasives.

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Available online: https://doi.org/10.5343/bms.2016.1135

*The potential effects of pre-settlement processes on post-settlement growth and survival of juvenile northern rock sole (*Lepidopsetta polyxystra*) Gulf of Alaska nursery habitats*
Estuarine, Coastal, and Shelf Science (2.762)
E. Fedewa, J. A. Miller, **T. P. Hurst (NMFS/AKFSC),** and D. Jiang

- Environmental variability, specifically temperature, impacts the growth of juvenile northern rock sole, *Lepidopsetta polyxystra*, a species of fisheries importance.
- There is a positive relationship between water temperature and nursery growth, and growth was not related to nursery site fish densities.
- Post-settlement survival of northern rock sole is related to early life variation in size and temperature effects in the Gulf of Alaska.

Early life history traits in marine fish such as growth, size, and timing of life history transitions often vary in response to environmental conditions. Identifying the potential effects of trait variation across life history stages is critical to understanding growth, recruitment, and survival. Juvenile northern rock sole (*Lepidopsetta polyxystra*) were collected (2005, 2007, 2009-2011) from two coastal nurseries in the Gulf of Alaska during the early post-settlement period (July-August) to examine variation in early life history traits in relation to water

temperature and juvenile densities in nurseries as well as to evaluate the potential for carry-over effects. Size-at-hatch, larval growth, metamorphosis size and timing, and post-metamorphic and recent growth of juveniles were quantified using otolith structural analysis and compared across years and sites. Additionally, traits of fish caught in July and August were compared for evidence of selective mortality. Post-metamorphic and recent growth were related to temperatures in nurseries as well as temperatures during the larval period, indicating a direct influence of concurrent nursery temperatures and a potential indirect effect of thermal conditions experienced by larvae. Correlations between metamorphic traits and fish size at capture demonstrated that interannual variation in size persisted across life history stages regardless of post-settlement growth patterns. No evidence of density-dependent growth or growth-selective mortality were detected during the early post-settlement period; however, differences in hatch size and metamorphosis timing between fish collected in July and August indicate a selective loss of individuals although the pattern varied across years. Overall, variation in size acquired early in life and temperature effects on the phenology of metamorphosis may influence the direction of selection and survival of northern rock sole.
Publication date: April 5, 2017
Available online:
http://www.sciencedirect.com/science/article/pii/S0272771417302160

Experimental assessment of circle versus J hook performance and selectivity in the northern Gulf of Mexico recreational reef fish fishery
ICES Journal of Marine Science (2.626)
S. B. Garner, W. F. Patterson III, and **C. E. Porch (NMFS/SEFSC)**

- Effects of hook type (circle versus J hook) and hook size (1/0, 4/0, and 7/0) were tested for red snapper and gray triggerfish catch composition, traumatic hooking, species-specific catch, and size-selectivity.
- Hook type did not affect catches, and increasing hook size generally resulted in lower catches.
- Circle hook regulation may have reduced traumatic hooking mortality by up to 50%.
- Strong dome-shaped selection estimated for nearly all selectivity curves suggest logistic size-selectivity assumptions in assessment models are likely inappropriate for recreational sectors targeting red snapper or gray triggerfish.

Few data exist to evaluate the performance or assess the potential impacts on catchability and selectivity of hook regulations for recreational fisheries in the northern Gulf of Mexico. The purpose of this study was to test the effects of hook type (circle versus J hook) and hook size (1/0, 4/0, and 7/0) on catch composition, traumatic hooking, species-specific catch, and size-selectivity of red snapper, *Lutjanus campechanus*, and gray triggerfish, *Balistes capriscus*. Selectivity was estimated by conditioning size distributions from hook-specific catches against in situ size distributions observed with a remotely operated vehicle. Deep hooking (hook set in gills or beyond) was low in all hook treatments for red snapper and gray triggerfish, but was generally higher with J hooks, especially for other fishes with the largest J hook (34%). Hook type did not significantly affect catches, but catches decreased significantly with increasing hook size in all groups except red snapper. Selectivity curves were dome-shaped for both focus species in all hook treatments and selection peaks were similar among treatments for red snapper. Peak selectivity was 68.4 mm larger for J hooks than circle hooks for gray triggerfish. Overall, study results indicate that the circle hook regulation may have reduced traumatic hooking mortality by up to 50%, and that catchability is similar between hook types for both red snapper and gray triggerfish when controlling for hook size. Strong dome-shaped selection estimated for nearly all selectivity curves suggest logistic size-selectivity assumptions in assessment models are likely inappropriate for recreational sectors targeting red snapper or gray triggerfish.
Acceptance date: February 8, 2017

Bayesian stock assessment of Pacific herring in Prince William Sound, Alaska
PLOS ONE (3.234)
M. L. Muradian, T. A. Branch, S. D. Moffitt, and **P. F. Hulson (NMFS/AKFSC)**

- Performs first Bayesian assessment for Prince William Sound Pacific herring
- Our revised model could be used to manage herring stocks with a decision rule that considers both stock status and the uncertainty in stock status.

The Pacific herring (*Clupea pallasii*) population in Prince William Sound, Alaska crashed in 1993 and has yet to recover, affecting food web dynamics in the Sound and impacting Alaskan communities. To help researchers design and implement the most effective monitoring, management, and recovery programs, a Bayesian assessment of Prince William Sound herring was developed by reformulating the current model used by the Alaska Department of Fish and Game. The Bayesian model estimated pre-fishery spawning biomass of herring age-3 and older in 2013 to be a median of 19,410 mt (95% credibility interval 12,150±31,740 mt), with a

54% probability that biomass in 2013 was below the management limit used to regulate fisheries in Prince William Sound. The main advantages of the Bayesian model are that it can more objectively weigh different datasets and provide estimates of uncertainty for model parameters and outputs, unlike the weighted sum-of-squares used in the original model. In addition, the revised model could be used to manage herring stocks with a decision rule that considers both stock status and the uncertainty in stock status.
Publication date: February 21, 2017
Available online: http://dx.doi.org/10.1371/journal.pone.0172153

Evolutionary restoration potential evaluated through the use of a trait-linked genetic marker
Evolutionary Applications (4.572)
T. Apgar, **D. Pearse (NMFS/SWFSC)**, and E. Palkovacs

- Complete barriers to migration such as dams are associated with major reductions in the frequency of anadromy-associated alleles, while partial barriers have a cumulative effect.
- Results show that removal of multiple small, partial, barriers to anadromy may be a cost effective tool for the evolutionary restoration of anadromous fish migrations.

Human-driven evolution can impact ecological roles and conservation values of impacted populations. Most evolutionary restoration approaches focus on manipulating gene flow, but an alternative approach is to manipulate the selection regime to restore historic or desired trait values. Here we examined the potential utility of this approach to restore anadromous migratory behavior in coastal California steelhead trout (*Oncorhynchus mykiss*). We evaluated the effects of natural and anthropogenic environmental variables on the observed frequency of alleles at genomic marker tightly associated with migratory behavior across 39 O. mykiss populations from across California, USA. We then modeled the effectiveness of different restoration strategies for shifting selection and restoring anadromy. We found that complete barriers such as dams cause major reductions in the frequency of anadromous alleles. The removal of dams is expected to restore anadromy significantly. Interestingly, accumulations of large numbers of partial barriers within watersheds also appear to have reduced migratory behavior significantly. Restoration involving the removal of small partial barriers should be evaluated alongside fishway construction and dam removal as cost-effective tools

to restore anadromous fish migrations. We encourage broader considerations of in situ evolution during the development of habitat restoration projects.
Publication date: March 27, 2017
Available online: http://onlinelibrary.wiley.com/doi/10.1111/eva.12471/epdf

Facilitation in Caribbean coral reefs: high densities of staghorn coral foster greater coral condition and reef fish composition
Oecologia (2.902)
B. Huntington**, M. W. Miller (NMFS/SEFSC),** L. Richter, and R. E. Pausch

- The study documents the status of ESA listed staghorn coral from a range of natural and restored sites. The results suggest that beneficial feedbacks (e.g., higher fish diversity and coral condition) may occur at VERY high levels of coral abundance; many extant 'thickets' are not dense enough to reach this facilitative threshold.
- This suggests that a much higher target for density of restored staghorn populations may provide functional benefits, especially in locations with an intact fish assemblage

Recovery of the threatened staghorn coral (*Acropora cervicornis*) is posited to play a key role in Caribbean reef resilience. At four Caribbean locations (including one restored and three extant populations), we quantified characteristics of contemporary staghorn coral across increasing conspecific densities, and investigated a hypothesis of facilitation between staghorn coral and reef fishes. High staghorn densities in the Dry Tortugas exhibited significantly less partial mortality, higher branch growth, and supported greater fish abundances compared to lower densities within the same population. In contrast, partial mortality, branch growth, and fish community composition did not vary with staghorn density at the three other study locations where staghorn densities were lower overall. This suggests density-dependent effects between the coral and fish community may only manifest at high staghorn densities. We then evaluated one facilitative mechanism for such density-dependence, whereby abundant fishes sheltering in dense staghorn aggregations deliver nutrients back to the coral, fueling faster coral growth, thereby creating more fish habitat. Indeed, dense staghorn aggregations within the Dry Tortugas exhibited significantly higher growth rates, tissue nitrogen, and zooxanthellae densities than sparse aggregations. Similarly, higher tissue nitrogen was induced in a macroalgae bioassay outplanted into the same dense and sparse aggregations, confirming greater bioavailability of nutrients at high staghorn densities. Our findings inform staghorn restoration efforts,

suggesting the most effective targets may be higher coral densities than previously thought. These coral-dense aggregations may reap the benefits of positive facilitation between the staghorn and fish community, favoring the growth and survivorship of this threatened species.
Acceptance date: March 6, 2017

Growth and maturation of the red lip parrotfish Scarus rubroviolaceus
Journal of Fish Biology (1.658)
B. M. Taylor (NOAA/PIFSC) and C. Pardee

- Estimation of life-history characteristics for the red lip parrotfish directly applicable to stock assessment.
- Examination of life-history variation across sea surface temperature gradients.

This study presents age-based life-history information for the red lip parrotfish, *Scarus rubroviolaceus*, based on a 5-year sampling program from the commercial fishery of American Samoa. Females reached sexual maturity at 31.9 cm fork length (LF) and 2.6 years, and sex change occurred at 42.3 cm LF, although not all females change sex through their ontogeny. The maximum observed age was 14 years and approximately 65% of the fishery harvest was above the median LF at sex change.
Acceptance date: March 7, 2017

Assessing the diet of North American Atlantic salmon (Salmo salar L.) off the West Greenland coast using gut content and stable isotope analyses
Fisheries Oceanography (2.73)
H. Dixon, J. Dempson, **T. Sheehan, M. Renkawitz (NOAA/NEFSC)**, and M. Power

- Atlantic salmon are an opportunistic generalist predator whose diet varies spatially and temporally at regional and oceanic scales
- Limited studies to date prevent adequate characterization of Atlantic salmon vulnerabilities to changes in future prey composition due to changing climate and therefore the implications remain unknown
- Further study to document spatial and temporal dietary variation and changes in availability and quality of prey are required before definitive conclusions can be drawn about the trophic effects of oceanic regime change on Atlantic salmon

Atlantic are limited compared with the Northeast Atlantic. Climate-induced changes to food webs in Atlantic salmon feeding areas have been noted, alongside increased mortality despite a cessation of most marine fisheries. As forage efficiency may be hampering survival, it was important to address this knowledge gap. Atlantic salmon were sampled at three sites on the West Greenland coast (Sisimiut, Nuuk and Qaqortoq) between 2009 and 2011. Gut content and stable isotope analyses were combined to assess spatial and temporal differences in feeding. Capelin (*Mallotus villosus*) dominated the diet at Nuuk and Qaqortoq, whereas boreoatlantic armhook squid (*Gonatus fabricii*) was the dominant prey at Sisimiut. Hyperiid amphipods (*Themisto* spp.) and sand lance (*Ammodytes* spp.) were also important. Significant differences were found among sites for both gut contents and stable isotope analyses, with fewer differences evident temporally. Dietary differences were also evident across larger scales, with little overlap demonstrated with Northeast Atlantic diets and the emergence of boreoatlantic armhook squid as an important prey item over time. Atlantic salmon diets are frequently anchored on one or two prey items, on which they appear to specialize, but they will diversify to consume other available pelagic prey. Thus, Atlantic salmon are an opportunistic, generalist predator within the pelagic food web. The variability evident in diet suggests that the limited data available are insufficient to appropriately understand potential vulnerabilities that the species may have to ecosystem changes, and suggest further research is needed.
Acceptance date: February 13, 2017

OAR Publications

Exploring the ocean for hydrothermal venting: New techniques, new discoveries, new insights
Ore Geology Reviews (3.72)
E. T. Baker (OAR/PMEL)

- Four decades of ocean exploration have discovered >630 submarine hydrothermal sites.
- 80% of sites occur on ocean ridges; site frequency increases with spreading rate.
- New exploration methods suggest a 3-6× underestimation of site frequency on ridges.

- Underestimation hinders quantitative modeling of important Earth-ocean interactions.

Enumerating active hydrothermal fields on the seafloor has been a challenge since their discovery almost 40 years ago. High-temperature hydrothermal fields are readily discoverable, primarily by detecting mineral-laden plumes, but low-temperature, particle-poor vent fields resist discovery. Decades of exploration for vent fields have covered, though often cursorily, about one-third of the global lengths of both oceanic spreading ridges (OSRs) and volcanic arcs, identifying some 630 active vent fields. About 80% of these fields are on OSRs, and the spatial frequency of those fields is currently estimated as ~0.5–5/100 km, generally increasing with spreading rate. Over the last decade, however, a few detailed surveys have added sensors capable of detecting ephemeral chemical tracers (oxidation-reduction potential) in addition to standard sensors that detect quasi-conservative optical tracers (such as light backscattering). This approach has revealed a new view of the distribution of venting fields along fast-spreading (>55 mm/yr) OSRs. Studies of four such ridge sections totaling 1470 km length suggest that the present inventory of vent fields may underestimate the true global population of vent fields on fast-spreading OSRs by a factor of 3–6. This increase implies that ridge axes are unexpectedly "leaky" reservoirs, from which hydrothermal fluids escape at far more sites than presently assumed; that the supply of dissolved hydrothermal iron, which may be fertilizing the primary production of the Southern Ocean, is higher than now calculated; and that present estimates of recoverable sulfide tonnage from ridge axes may be too low. Along slow-spreading ridges, which account for 60% of the global OSR length and 86% of known sulfide tonnage, expansive axial valleys present special exploration challenges that will not be easily overcome.
Publication date: February 9, 2017
Available online:
http://www.sciencedirect.com/science/article/pii/S0169136816304103

Focusing of internal tides by near-inertial waves
Geophysical Research Letters (4.212)
Y. Cuypers, P. Bouruet-Aubertot, J. Vialard, and **M.J. McPhaden (OAR/PMEL)**

- Observations above the central Indian ridge show that internal tide generated there was focused and trapped by a strong near inertial wave
- Ray modeling of trapped internal tides shows region of dramatic shear increase in the pycnocline

- Dissipation of internal tide by this mechanism has a potential global relevance for ocean mixing

The refraction of internal waves by lower-frequency near-inertial waves has been predicted theoretically, but never observed before. Here, we report observations of semi-diurnal internal tides generated by the rough topography of the Central Indian Ridge, in the presence of a strong, lower-frequency near-inertial wave field generated by a tropical storm. The semi-diurnal internal tide energy is trapped within upward-propagating bands with a periodicity close to the inertial period. A ray-tracing model suggests that this trapping results from the internal tide refraction by the shear associated with near-inertial waves. This yields a strong increase of the internal tide energy and shear in space-time regions where the background flow focuses the rays, leading to the formation of caustics. This mechanism may increase vertical mixing generated by baroclinic tides in the vicinity of mid-ocean ridges in tropical regions.
Publication date: March 4, 2017
Available online: http://onlinelibrary.wiley.com/doi/10.1002/2017GL072625/full

Calculating surface ocean pCO2 from biogeochemical ARGO floats equipped with pH - an uncertainty analysis
Global Biogeochemical Cycles (4.495)
N. L. Williams (OAR/PMEL), L.W. Juranek, **R. A. Feely (OAR/PMEL)**, K. S. Johnson, J. L. Sarmiento, L. D. Talley, A. G. Dickson, A. R. Gray, **R. Wanninkhof (OAR/AOML)**, J. L. Russell, S. C. Riser, and Y. Takeshita

- Surface ocean partial pressure of carbon dioxide (pCO2sw) is calculated from pH on biogeochemical profiling floats.
- The relative standard uncertainty in float pCO2sw estimates is 2.4% (or 10 µatm at pCO2sw of 400 µatm).
- For the first time extensive wintertime pCO2sw values were obtained in the Southern Ocean showing higher values than previous estimates.

More than 74 biogeochemical profiling floats that measure water column pH, oxygen, nitrate, fluorescence, and backscattering at 10-day intervals have been deployed throughout the Southern Ocean. Calculating the surface ocean partial pressure of carbon dioxide (pCO2sw) from float pH has uncertainty contributions from the pH sensor, the alkalinity estimate, and carbonate system equilibrium constants, resulting in a relative standard uncertainty in pCO2sw of 2.4% (or 10 µatm at pCO2sw of 400 µatm). The calculated pCO2sw from several floats spanning a range of oceanographic regimes are compared to existing climatologies.

In some locations, such as the Subantarctic zone, the float data closely match the climatologies, but in the Polar Antarctic Zone significantly higher pCO2sw are calculated in the wintertime implying a greater air-sea CO2 efflux estimate. Our results based on four representative floats suggest that despite their uncertainty relative to direct measurements the float data can be used to improve estimates for air-sea carbon flux, as well as to increase knowledge of spatial, seasonal, and interannual variability in this flux.
Publication date: March 3, 2017
Available online: http://onlinelibrary.wiley.com/doi/10.1002/2016GB005541/full

A practical set of miniaturized instruments for vertical profiling of aerosol physical properties
Aerosol Science and Technology (1.953)
H. Telg (OAR/ESRL), D. M. Murphy (OAR/ESRL), T. S. Bates (OAR/PMEL), J. E. Johnson (OAR/PMEL), P. K. Quinn (OAR/PMEL), F. Giardi, and **R. -S. Gao (OAR/ESRL)**

- We demonstrate a practical set of miniaturized instruments that can be deployed onboard small unmanned aircraft systems.
- These instruments can provide valuable information on ambient aerosol, including size-resolved particle number concentrations, aerosol absorption coefficient, relative humidity, and direct sun intensity.
- From these parameters it is possible to derive a comprehensive set of aerosol optical properties: aerosol optical depth, single scattering albedo, and asymmetry parameter.

In situ atmospheric aerosol measurements have been performed from a Manta unmanned aircraft system (UAS) using recently developed miniaturized aerosol instruments. Flights were conducted up to an altitude of 3000 m (AMSL) during spring 2015 in Ny-Ålesund, Svalbard, Norway. We use these flights to demonstrate a practical set of miniaturized instruments that can be deployed onboard small UASs and can provide valuable information on ambient aerosol. Measured properties include size-resolved particle number concentrations, aerosol absorption coefficient, relative humidity, and direct sun intensity. From these parameters it is possible to derive a comprehensive set of aerosol optical properties: aerosol optical depth, single scattering albedo, and asymmetry parameter. The combination of instruments also allows us to determine the aerosol hygroscopicity.
Publication date: February 21, 2017

Available online:
http://www.tandfonline.com/doi/abs/10.1080/02786826.2017.1296103

Assessment of the underestimation of snowfall accumulation by tipping bucket gauges used operationally by the Spanish national weather service
Atmospheric Measurement Techniques (2.989)
S. T. Buisan, M. E. Earle, J. L. Collado**, J. Kochendorfer (OAR/ARL)**, J. Alastrué, M. Wolff, C. D. Smith, and J. I. López-Moreno

- A transfer function (or adjustment) was derived for snowfall that removed the undercatch bias that such gauges experience as a function of wind speed.
- The use of tipping buckets is prevalent throughout the world, and for this reason the underestimation of snowfall precipitation from such gauges is an important problem.
- The methodology presented here can be used by other national weather services to test precipitation adjustments and to identify regions where errors are significant.

Within the framework of the WMO-SPICE (Solid Precipitation Intercomparison Experiment) at the Formigal-Sarrios test site located in the Pyrenees mountain range of Spain, the Thies tipping bucket precipitation gauge was assessed against the SPICE reference. The Thies gauge is the most widely-used precipitation gauge by the Spanish Meteorological State Agency (AEMET) for the measurement of all precipitation types, including snow. It is therefore critical that its performance be characterized. The first objective of this study is to derive transfer functions based on the relationships between catch ratio and wind speed and temperature. Multiple linear regression was applied to 1 h and 3 h accumulation periods, confirming that wind is the most dominant environmental variable affecting the gauge catch efficiency, especially during snowfall events. At wind speeds of 1.5 m s−1 the average catch ratio was 0.7. At 3 m s−1, the average catch ratio was 0.5, and was even lower for temperatures below −2 ºC and decreased to 0.2 or less for higher wind speeds. Following this, this study outlines two areas in Northern Spain that exhibit different catch ratios under weather conditions leading to snowfall events, highlighting the importance of how the precipitation gauge behaves in various conditions.
Publication date: March 16, 2017
Available online: http://www.atmos-meas-tech.net/10/1079/2017/amt-10-1079-2017.pdf

On the role of sea-state in bubble-mediated air-sea gas flux during a winter storm
Journal of Geophysical Research Oceans (3.44)
J. H. Liang, S. R. Emerson, E. A. D'Asaro, C. L. McNeil, R. R. Harcourt, P. P. Sullivan, B. Yang, and **M. F. Cronin (OAR/PMEL)**

- Observed gases in the sea surface during a winter storm are reproduced by a bubble-resolving model.
- Bubbles play an important role in mixed-layer dissolved gas budgets during the winter storm.
- Bubble-mediated gas flux is larger for smaller wave age due to the greater prevalence of large breaking waves in a younger sea.

Oceanic bubbles play an important role in the air-sea exchange of weakly soluble gases at moderate to high wind speeds. A Lagrangian bubble model embedded in a large eddy simulation model is developed to study bubbles and their influence on dissolved gases in the upper ocean. The transient evolution of mixed-layer dissolved oxygen and nitrogen gases at Ocean Station Papa (50ºN, 145ºW) during a winter storm are reproduced with the model. Among different physical processes, gas bubbles are the most important in elevating dissolved gas concentrations during the storm, while atmospheric pressure governs the variability of gas saturation anomaly (the relative departure of dissolved gas concentration from the saturation concentration). For the same wind speed, bubble-mediated gas fluxes are larger during rising wind with smaller wave age than during falling wind with larger wave age. Wave conditions are the primary cause for the bubble gas flux difference: When wind strengthens, waves are less-developed with respect to wind, resulting in more frequent large breaking waves. Bubble generation in large breaking waves is favorable for a large bubble-mediated gas flux. The wave age dependence is not included in any existing bubble-mediated gas flux parameterizations.

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NESDIS Publications

Circulation Analysis in the Northwest Indian Ocean Using ARGO Floats and Surface Drifter Observations, and SODA Reanalysis Output
Dynamics of Atmospheres and Oceans (1.439)
S. S. Vitale, S. F. DiMarco, H. F. Seidel, **Z. Wang (NESDIS/NCEI)**

- This is the first compilation of surface drifter and ARGO float velocity data in the northwest Indian Ocean.
- In this study, we quantified seasonal surface and subsurface velocities in the Northwest Indian Ocean from surface drifter and ARGO float data.
- During the spring and fall, data suggest highly variable subsurface flow, and surface currents representative of the transition between the NE and SW monsoons.

This study incorporates observations from Array of Real-time Geostrophic Oceanography (ARGO) floats and surface drifters to identify seasonal circulation patterns at the surface, 1000 m, 1500 m, and 2000 m in the northwest Indian Ocean, and quantify velocities associated with them. A skill comparison of the Simple Ocean Data Assimilation (SODA) reanalysis output was also performed to contribute to the understanding of the circulation dynamics in this region. Subsurface currents were quantified and validated using the ARGO float data. Surface currents were identified using surface drifter data and compared to the subsurface observations to enhance our previous understanding of surface circulations. Quantified Southwest Monsoon surface currents include the Somali Current (vmax = 179.5 cm/s), the East Arabian Current (vmax = 52.3 cm/s), and the Southwest Monsoon Current (vmax = 51.2 cm/s). Northeastward flow along the Somali coast is also observed at 1000 m (vmax = 26.1 cm/s) and 1500 m (vmax = 12.7 cm/s). Currents associated with the Great Whirl are observed at the surface (vmax = 161.4 cm/s) and at 1000 m (vmax = 16.2 cm/s). In contrast to previous studies, both ARGO and surface drifter data show the Great Whirl can form as early as the boreal Spring intermonsoon, lasting until the boreal Fall intermonsoon. The Arabian Sea exhibits eastward/southeastward flow at the surface, 1000 m, 1500 m, and 2000 m. Quantified Northeast Monsoon surface currents include the Somali Current (vmax = 97.3 cm/s), Northeast Monsoon Current (vmax = 30.0 cm/s), and the North Equatorial Current (vmax = 28.5 cm/s). Southwestward flow along the Somali coast extends as deep as 1500 m. Point-by-point vector and scalar correlations of SODA output to ARGO and surface drifter data showed that surface SODA output and surface drifter data generally produced a strong correlation

attributed to surface currents strongly controlled by the monsoons, while subsurface correlations of SODA output and ARGO were mostly insignificant due to variability associated with intermonsoonal transitions. SODA output produced overall smaller velocities than both observational datasets. Assimilating ARGO velocities into the SODA reanalysis could improve subsurface velocity assimilation, especially during the boreal fall and spring when ARGO observations suggest that flow is highly variable.
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